Claims

1. Device for image processing and learning comprising at least a "multi electrode array" (MEA), over which an homogeneous culture of interconnected neurons, so that forming a cell network, is grown on, wherein said MEA is able to stimulate and record the electric activity of said neurons.

2. Method for parallel processing a digital image comprising the following steps:
a) mapping a digital image ($I_{1,2}(x,y)$) (INPUT) having a resolution of 1 or 2 bit ($I_1(x,y)$) or $I_2(x,y)$) in the case the image is of 1 or 2 bit respectively) of NxN pixel in voltage pulses of 2 or 4 intensity levels applied to a matrix of NxN integrated electrodes on a multi-electrode array (MEA), where spontaneaously interconnected neurons, so that forming a cell network, are maintained in culture;
b) elaborating the image from said neurons by means of the kernel of convolution:

$$h(\rho,\sigma,t) = A(t) \exp((\rho - \rho(t)) / 2\ \sigma(t)^2) \quad (1)$$

$\rho^2 = x^2 + y^2$

c) registering the electric activity of said neurons by means of extracellular MEA electric signals (by voltage) and
d) revealing, for each single electrode and in subsequent time intervals, spikes or firings associated to action potentials generated by said neurons.

3. Method according to claim 2 wherein the firing rate FR(x,y,t) (OUTPUT), measured by the electrode in position (x,y) and during a time interval centered in t, is recorded.

4. Method according to claim 3 wherein the INPUT and the OUTPUT are related by the equation:

$$FR(x,y,t) = I_{1,2}(x,y) ** h(\rho,\sigma,t) \quad (2)$$

where ** indicates a two-dimensional convolution.

5. Method according to claim 2 wherein the INPUT digital image ($I_8(x,y)$) is defined by 8 bit and is divided into 4 or 8 images (I_{mi}), each having 2 or 1 bit respectively, where m is 2 or 1 respectively, according to the equation:

$$I_8(x,y)=\sum_{1}^{8/m} I_{mi}\, 2^{m(i-1)} \qquad (3)$$

and each single image I_{mi} is filtered indipendently and then reassembled in an unique 8 bit image, wherein the whole process of dividing, filtering and reassembling is according to the equation:

$$\sum_{1}^{8/m} 2^{m(i-1)}\, I_{mi} ** h(\rho,\sigma,t) \qquad (4)$$

so that the 8 bit image $I_8(x,y)$ is processed with a 8 bit resolution.

6. Method for digital image processing and learning comprising the following steps:

a) stimulate a matrix of NxN electrodes on a multi-electrode array (MEA), where spontaneaosly interconnected neuronal cells, so that forming a cell network, are maintained in culture, by means of a tetanic stimulation composed by bipolar voltage pulses having a frequency of at least 100 Hz, and having at least a pair of non colinear segments ($I_{1,2}(x,y)$) (INPUT), in order to induce learning or potentiation;

b) measuring the firing rate $FR_{1,2}(x,y,t)$ evoked by the INPUT image;

c) processing the INPUT image as a 8 bit image according to the equation:

$$\sum_{1}^{8/m} 2^{m(i-1)}\, FR_{m,i}(x,y) \qquad (5)$$

where $FR_{m,i}(x,y)$ is the measured response to $I_{mi}(x,y)$ after the tetanization.

7. Method for digital image processing and learning according to claim 6 wherein the INPUT image is larger than 1000 x 1000 pixel.